Volume 1(5), pages 327-335, October 2025
DOI: 10.65221/0049
eISSN: 3115-5898

https://reports.afjur.com

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African Research Reports

Regular Research Paper

Market information needs and access barriers of smallholder orange farmers in Tanzania

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Received 27 August 2025; Accepted 29 September, 2025

This study examines market information barriers among smallholder orange farmers in Tanzania, employing Rogers' Diffusion of Innovations theory as an analytical lens. A mixed-methods design was adopted, combining a household survey of 133 farmers (103 valid responses, 77.4% response rate) with four semi-structured interviews involving village leaders and agricultural extension officers, supplemented by document reviews. The objectives of the study are (i) to determine the specific market information needs of orange farmers in Muheza District, and (ii) to identify barriers affecting their access and use of such information. Findings reveal that digital exclusion driven by low literacy, linguistic incompatibility, and infrastructural gaps disproportionately restricts farmers' access to critical knowledge on price negotiation and quality standards. Quantitative results show that 61% of respondents were women and 72% were under the age of 50, highlighting both gendered constraints and generational differences in technology adoption. Women, constituting the majority of growers, face compounded marginalisation through limited mobility and resource access. Unlike staple crops, Tanzania's perishable orange sector demands real-time market intelligence, yet institutional voids and incompatible innovation design hinder adoption. The study establishes novel intersections between gender dynamics, crop-specific value chains, and technology adoption constraints. It calls for blended analog-digital information systems, gender-responsive extension services, and community-centered platforms to bridge access gaps. Implications advance inclusive agricultural innovation frameworks for perishable crop economies in the Global South.

Key words: Smallholder farmers, market information systems, ICT4Ag, agricultural extension, gender in agriculture, Tanzania.

INTRODUCTION

Agriculture is the heart and soul of Tanzania's economy, providing a livelihood for over 65% of its people and contributing roughly 27% to the nation's GDP. Among the many crops that thrive in Tanzania's fertile lands, oranges stand out as a shining star. Known as the country's golden crop, oranges have made Tanzania East Africa's top producer, with harvests growing by an impressive 14% each year. In Muheza District, smallholder farmers are the backbone of this citrus success, pouring their hard work and dedication into every tree they tend.

Despite production growth, Tanzania's orange sector is yet to fully exploit regional and international trade opportunities. Oranges from Muheza and other citrus-growing zones supply mainly domestic markets in Dar es Salaam and Tanga, with only a small proportion reaching

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neighbouring countries. To illustrate the broader potential, in 2023, Tanzania's horticultural exports (fruits, vegetables, flowers, spices) earned approximately USD 417.7 million, up from about USD 290.1 million in 2022, representing a growth of nearly 44% (The Citizen, 2024). The government has set a target of USD 2 billion in horticultural export earnings by 2030 under its Agenda 10/30 policy (FreshPlaza, 2023). Despite this horticultural boom, detailed trade data show that oranges themselves accounted for only about USD 194,000 worth of exports (approximately 617 tonnes) in 2023, mainly destined for Uganda and Kenya (World Bank, 2023). This stark contrast between high horticultural earnings and the limited role of oranges underscores the importance of market information, quality standards, and trade linkages for unlocking the crop's potential.

Beneath this thriving industry lies a hidden struggle. While research often focuses on staple crops like maize or broad technological fixes, the specific challenges faced by Muheza's orange farmers are frequently ignored. Oranges are perishable, making timely market access critical, and local barriers—like exploitative middlemen and spoilage—can rob farmers of over 30% of their income. Studies of Siwandeti et al. (2023) highlight how supply chain issues limit market participation, a problem that likely affects citrus farmers as much as it does maize growers. Similarly, Changalima and Ismail (2022) point to infrastructure challenges that hinder smallholder farmers, a reality that resonates in Muheza's citrus groves. Diwakar et al. (2023) add that smallholders in developing countries struggle to connect with modern supply chains, which further deepens their losses.

Access to reliable market information—prices, buyers, and quality standards—is another hurdle. Mapiye et al. (2023) found that smallholder farmers across sub-Saharan Africa, including Tanzania, often lack the digital skills and tools needed to access timely market data. McCampbell et al. (2023) echo this, noting that Rwandan farmers face similar barriers to using phone-based tools, a challenge that likely applies to Muheza's orange growers. Kalimangasi et al. (2021) also point out that high costs and limited training restrict mobile phone use among Tanzanian grape farmers, a situation that likely mirrors the citrus sector. Poor connectivity and expensive data, as Kapari et al. (2024) found in South Africa, further complicate access to digital solutions.

Gender adds another layer of complexity. Awoke et al. (2025) show that women farmers in Tanzania's Dodoma region are often cut off from information networks, limiting their ability to adopt new practices. Mazibuko et al. (2023) highlight how cultural norms can restrict women's use of digital tools, a barrier that likely affects female orange farmers in Muheza. Infrastructure and support systems are also critical. Silvestri et al. (2021) suggest that radio and SMS-based programs in Tanzania can boost sustainable practices, but weak extension services often limit their reach. Bontsa et al. (2023) argue that digital tools like mobile apps could transform market access, but only with better infrastructure and training. Financial barriers prevent farmers from investing in these solutions (Mazibuko et al., 2023).

This study turns to the Diffusion of Innovations theory to understand why market information doesn't reach Muheza's farmers. Dearing and Cox (2018) explain that innovations, like market information systems, spread through social networks but face obstacles like complexity and limited visibility. For Muheza's farmers, poor roads, digital divides, and overstretched support systems block the flow of vital knowledge. Kardan Moghaddam et al. (2022) emphasize that ease of use and clear benefits drive technology adoption, a principle that guides our approach here.

For farmers in Ngarani and Kwakifua villages, this is not just about data;it is about their survival. Without reliable market information, they face daily risks from middlemen and wasted harvests. Zondo and Ndoro (2023) suggest that social media and ICTs could transform communication for smallholders, but tailored solutions are needed to overcome adoption barriers. Omotoso and Omotayo (2024) stress the importance of targeted interventions to strengthen smallholder resilience and market access, underscoring the urgency of this work.

Our study listens to Muheza's orange farmers, seeking to understand their specific needs and the obstacles they face. We aim to co-create practical solutions grounded in their realities, blending local wisdom with innovative tools to secure their livelihoods and strengthen Tanzania's citrus legacy. Specifically, this study is guided by two objectives: (1) Determine the precise market information needs of smallholder orange farmers in Ngarani and Kwakifua villages, Muheza District; and (2) Uncover the barriers these farmers face in accessing and using such information.

Theoretical framework

At its heart, this study asks a simple question: *Why does life-changing knowledge like fair prices or buyer demands often fail to reach the farmers who need it most?* To unravel this, we turn to Everett Rogers' Diffusion of Innovations (DOI) Theory. Imagine market information not as data, but as a seed of change. For Muheza's orange farmers, this seed could grow into better harvest timing, stronger bargaining power, and rescued profits. But like any seed, it needs the right soil to take root. DOI reveals five essentials for growth: farmers must see its *advantage*, find it *compatible* with their lives, perceive it as *simple*, test it (*trialability*), and witness it working (*observability*). Our work breathes fresh life into this theory by planting it in neglected soil: the world of perishable oranges and gendered barriers in East Africa**.** While others applied DOI broadly to "technology,"

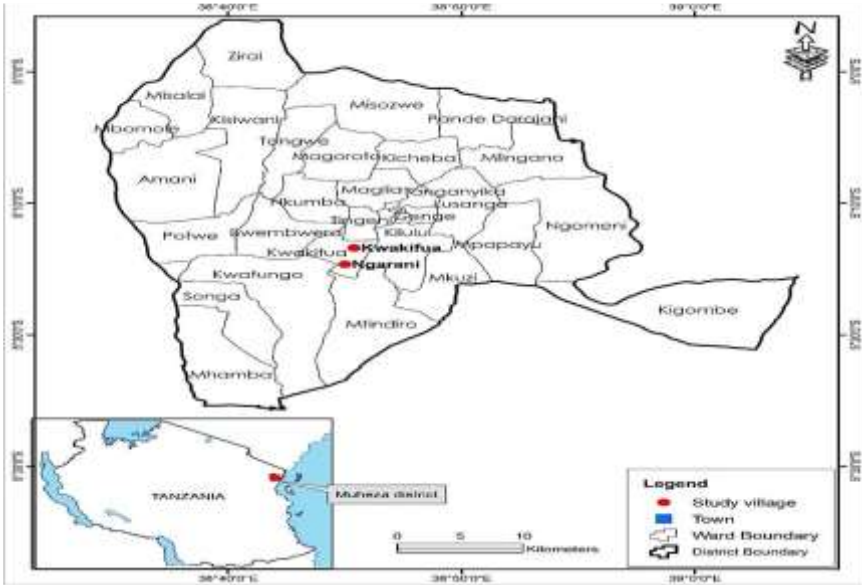

Figure 1. Location of Ngarani and Kwakifua Villages in Muheza District, Tanzania.

we listen to farmers like Mama Asha (61, Ngarani), who told us: *"I hear about mobile prices, but phones are for my sons I can't read the screen."* Here, market information is not just an app it is an *intangible innovation* battling unique storms.

Consider compatibility**:** When price alerts arrive in English instead of Kiswahili a mismatch for 29% of our respondents or apps ignore low-literacy users, the innovation feels foreign, like a song in the wrong key. Complexity deepens the divide: 88% of farmers lack ICT skills, leaving even basic smartphones gathering dust. And without observability no visible proof that neighbors profited from market data doubt thrives. *"Why risk new ways,"* asks farmer *"when we see no wins?"* What makes our approach new? First, we measure the invisible walls: 86% report extension officers vanish after harvest talks, starving them of guidance. 76% can't afford radios or smartphones, trapping them in hearsay. Second, we expose gender's hidden role: Women (61% of those we met) face triple exclusion fewer phones, scarcer training, and mobility limits yet DOI's *social systems* dimension clarifies why their adoption lags. Third, we honor crop urgency: Oranges spoil fast, making timely info a lifeline (*relative advantage*), yet Muheza's patchy roads sabotage delivery (*compatibility*).

For our first goal understanding farmers' thirst for market knowledge DOI lights the path. Those with strong networks (associations) or tech access grasp the *advantage* of negotiation skills (craved by 79%). Others, distanced from hubs or drowned in English reports, see innovation as a language they don't speak. As widow Zainab whispered: *"Habari kwa Kiingereza haisaidii wananchi!"* ("English information doesn't help ordinary people!").

For our second goal diagnosing barriers DOI decodes the struggle. No libraries? Broken channels suffocate *observability*. Low digital literacy (88%)? It renders innovation a tangled knot. Weak extension support (86%)? It starves the "guides" who make trial possible. Even poverty's grip (76% can't afford devices) shrinks the space for change. But theory without action is barren. DOI doesn't just diagnose it prescribes. Our findings demand solutions that fit like worn gloves: voice alerts in Swahili (not complex English apps), "success shadowing" where farmers witness neighbors thrive using market data, and community info-hubs with human helpers, not lonely screens. Grounding DOI in the soil of Muheza its women's resilience, its oranges' perishable truth we turn theory into tools for dignity.

MATERIALS AND METHODS

Description of the study area

The study was conducted in Muheza District, Tanga Region, Tanzania, covering a total area of 1,974 square kilometers. It has a population of 204,461, according to the 2022 Tanzanian National Census (National Bureau of Statistics, 2022). The district experiences a bimodal rainfall pattern, with two rainy seasons annually, ranging from two to four months depending on the year and local weather conditions, and an average annual rainfall of 1,100 to 1,400 mm (Tanzania Meteorological Authority, 2023). Rainfall is a critical determinant of agricultural productivity, particularly for orange farming, which is a cornerstone of livelihoods in the district. Muheza was selected purposively due to its prominence in orange production, contributing significantly to the local economy (URT, 2019). Two villages, Ngarani and Kwakifua, were chosen for their high volumes of orange production, ensuring relevance to the study's objectives (Figure 1).

Research design and approach

This study employed a descriptive research design within a mixed-methods framework, combining qualitative and quantitative data collection techniques. The descriptive design was selected to provide a detailed snapshot of the current market information needs and access challenges faced by smallholder orange farmers, as it is well-suited for capturing contextual and situational data (Sekaran and Bougie, 2016). The mixed-methods approach enhances the study's rigor through triangulation, allowing for the integration of diverse data sources interviews, questionnaires, and document reviews to validate findings and provide a holistic understanding of the research problem (Creswell and Plano Clark, 2018). Triangulation strengthens the validity of results by cross-verifying data from multiple perspectives, as supported by seminal mixed-methods research.

Sampling procedures and sample size

The study utilized a combination of purposive and simple random sampling techniques to ensure both relevance and representativeness. Purposive sampling was employed to select Ngarani and Kwakifua villages due to their significant orange production, as well as four key informants (two village leaders and two agricultural extension officers) based on their expertise and ability to provide in-depth contextual insights (Patton, 2015). Purposive sampling is justified for its efficiency and focus on information-rich cases, aligning with the study's aim to explore specific challenges in orange farming (Sekaran and Bougie, 2016). Simple random sampling was applied to select smallholder orange farmers from a sampling frame of 200 registered farmers (100 from each village), compiled with the assistance of village leaders. This method ensures each farmer had an equal chance of selection, reducing bias and enhancing the generalizability of findings within the sampled population (Cochran, 1977). The sample size was determined using Yamane's (1967) formula:

$$n = \frac{N}{1 + N(e)^2}$$

Where, n stands for the sample size, N stands for the population size, e for the margin of error and the target population under the study is 200, hence: n = 200/ (1+200*(0.05) 2 = 133. Thus, a sample size of 133 farmers was targeted, ensuring statistical reliability while remaining feasible for data collection.

Data collection methods

Data were collected using questionnaires, semi-structured interviews, and document reviews to ensure both breadth and depth of evidence. A total of 133 questionnaire items were distributed to smallholder orange farmers in Ngarani and Kwakifua villages. 103 were correctly completed and returned, yielding a response rate of 77.4%. Although the achieved sample was lower than the Yamane formula estimate, the realised response rate remains robust, as rates above 70% are generally considered acceptable for survey-based studies (Fowler, 2014). This shortfall may slightly reduce statistical power and limit the generalisability of the findings beyond the study area, but the data still provide reliable insights into farmers' realities**.** The questionnaire was divided into three sections: (i) demographic and socio-economic characteristics, (ii) access to and needs for market information, and (iii) barriers to information access. Closed-ended items applied multiple-choice and 5-point Likert scales to generate quantifiable data, while open-ended items captured additional perspectives. Reliability testing using Cronbach's alpha produced a coefficient of 0.82 for Sections 2 and 3, demonstrating strong internal consistency of the scale-based items.

To complement the survey data, semi-structured interviews were conducted with four key informants (two village leaders and two agricultural extension officers) to probe deeper into issues of information access, systemic barriers, and community practices. The flexible interview format allowed respondents to elaborate on experiences and emerging themes, enhancing the richness of the qualitative findings. Document reviews of agricultural reports, policy papers, and local government records further triangulated the evidence, ensuring that the study drew from both farmer voices and institutional perspectives. This mixed-methods approach provided a comprehensive understanding of smallholder orange farmers' market information needs and challenges**.**

Data quality control

To ensure data quality, several validity and reliability measures were implemented. For quantitative data, the questionnaire was pre-tested with a pilot group of 10 farmers (not included in the final sample) to identify ambiguities and refine questions, following recommendations by Dillman et al. (2014). Cronbach's alpha was calculated to assess the internal consistency of the questionnaire, yielding a value of 0.82, indicating high reliability (Nunnally, 1978). For qualitative data, interviews were audio-recorded (with consent) and transcribed verbatim to ensure accuracy. Member checking was conducted by sharing interview summaries with participants to verify interpretations, enhancing credibility (Lincoln and Guba, 1985). Triangulation across data sources (questionnaires, interviews, and document reviews) further strengthened the validity of findings.

Ethical considerations

Ethical considerations were prioritized throughout the study. Informed consent was obtained from all participants, with clear explanations of the study's purpose, voluntary participation, and confidentiality measures. Participants' identities were anonymized in all reports to protect privacy. The study adhered to ethical guidelines outlined by the American Psychological Association (APA, 2017), ensuring no harm to participants and respect for their autonomy.

Data processing, analysis, and presentation

Quantitative data from closed-ended questionnaire responses were coded and analyzed using the Statistical Package for the Social Sciences (SPSS) version 21. Descriptive statistics, including frequencies, means, and percentages were used to summarize findings, presented in tables and charts for clarity. Qualitative data from interviews and open-ended questionnaire responses were analyzed thematically using content analysis, following Braun and Clarke (2006)'s six-phase framework: familiarization, coding, theme generation, review, definition, and reporting. Themes were derived inductively to reflect participants' perspectives accurately. Qualitative findings are presented in narrative form, supported by direct quotes to enhance authenticity. The integration of quantitative and qualitative results was conducted through a convergent mixed-methods design, where both data types were analyzed separately and merged during interpretation to provide a comprehensive understanding (Creswell and Plano Clark, 2018).

RESULTS AND DISCUSSION

This section presents the findings thematically, aligned

Table 1. Response rate of study participants.

Category	Number distributed	Number responded	Response rate (%)
Smallholder Farmers	133	103	77.4
Key Informants (Interviews)	4	4	100
Total	137	107	78.1

Table 2. Background information of respondents (n=103).

Variable	Frequency	Percentage
Gender		
Male	40	39
Female	63	61
Age group		
21–30	22	21
31–40	29	28
41–50	24	23
51–60	16	16
61+	12	12

with the study objectives: identifying market information needs of smallholder orange farmers and exploring challenges in accessing and using market information in Muheza District, Tanzania. The results are integrated with Everett Rogers' Diffusion of Innovations Theory (Rogers, 2003) to interpret the adoption barriers and facilitators for market information systems. The findings contribute novel insights by focusing on orange farmers, a less studied group compared to staple crop farmers in Tanzanian agricultural research (Isaga and Kileo, 2022). Emphasis on gender-specific barriers, particularly for women, adds a unique perspective, aligning with feminist technology adoption frameworks (Wajcman, 2010). Qualitative data from key informant interviews are *italicized* to highlight their role in supporting and contextualizing survey findings.

Response rate and background information

The response rate and demographic profile of participants are critical for assessing data reliability and contextual relevance. A high response rate ensures representativeness, while demographic details illuminate how socio-economic factors shape market information needs and access challenges (Fowler, 2014) (Table 1). Of 133 questionnaires distributed to smallholder orange farmers in Ngarani and Kwakifua villages, 103 were completed and returned, yielding a 77.4% response rate. All four key informant interviews (two village leaders and two agricultural extension officers) were completed, achieving a 100% response rate. The overall response rate of 78.1% exceeds the 70% threshold considered robust for social science research, ensuring reliable analysis (Fowler, 2014). This high engagement supports the validity of the findings for addressing the study's objectives (Table 2).

The observed demographic profile reveals a predominance of female farmers (61%), consistent with studies affirming women's central role in Tanzanian small-scale agriculture (FAO, 2022; Mnimbo et al., 2017). Furthermore, the age distribution where 72% of participants are under 50 indicates population segment likely receptive to technological solutions, while the remaining 28% (aged 50+) provide critical insights into traditional practices. This heterogeneity enriches the analysis of technology adoption barriers, as younger farmers typically demonstrate greater openness to innovation (Rogers, 2003). However, the intersection of gender with other socio-economic variables such as income and education further complicates this picture. For instance, female farmers in the study often reported lower levels of formal education and more limited access to disposable income compared to their male counterparts, which in turn restricts their ability to invest in digital tools even when they are aware of them. Conversely, men with higher income levels were more likely to own smartphones and afford mobile data, highlighting how financial resources intersect with gender to shape access.

Consequently, these patterns underscore the necessity for agricultural information services to adopt gender-responsive designs that actively engage women, alongside age-differentiated strategies: leveraging digital tools for younger growers while intentionally preserving and integrating traditional knowledge systems held by

Table 3. Market information needs of smallholder orange farmers (n=103).

Market information need	SA (%)	A (%)	N (%)	D (%)	SD (%)
Price negotiation techniques	79	17	0	2	1
Product quality standards	73	21	1	3	2
Market outlets	67	22	1	4	6
Current market prices	64	12	0	12	12
Supply and demand trends	55	18	0	15	12
Supply trends	45	16	1	27	11
Sale timing and win/loss analysis	40	21	0	16	23
Transport cost	36	12	1	32	19
Market risk	31	9	1	21	38
Tax duties	27	7	1	47	18

SA = Strongly Agree, A = Agree, N = Neutral, D = Disagree, SD = Strongly Disagree.

older farmers. Additionally, intersectional programming is crucial targeted interventions should recognise that younger, educated women may face different barriers (such as cultural restrictions on market participation) compared to older, less-educated women whose challenges are compounded by both gender norms and generational divides. Designing solutions that address these overlapping disadvantages could significantly enhance inclusivity and ensure equitable access to agricultural information.

Market information needs of smallholder orange farmers

The study identified key market information needs through questionnaire responses and interviews, as summarized in Table 3**.** The table applies Rogers (2003)' Diffusion of Innovations framework to interpret how relative advantage, compatibility, and complexity influence information adoption. While previous Tanzanian studies have focused mainly on staple crops like maize (Isaga and Kileo, 2022), this study's emphasis on price negotiation and quality standards for oranges highlights unique market dynamics. Compared to maize, oranges are more vulnerable to post-harvest losses and intermediary exploitation, making skill-based and quality-oriented information particularly critical. These findings are also examined through gendered access barriers, especially the challenges faced by women.

Price negotiation techniques (79%)

The high demand for negotiation skills illustrates smallholders' susceptibility to exploitation within the orange value chain. Despite the clear relative advantage these skills offer for profitability (Rogers, 2003), low trialability due to limited practice opportunities constrains adoption. This differs from maize, where intermediaries' roles and market structures are more predictable (Isaga and Kileo, 2022). Targeted training programs simulating real buyer interactions are therefore essential to strengthen farmers' negotiation capacity. *"Possessing negotiation skills will help farmers negotiate reasonable prices for their oranges. Currently, smallholder farmers are being exploited by middlemen due to lack of such skills"* (Extension officer).

Product quality standards (73%)

Farmers' emphasis on quality standards demonstrates their strategic intent to enhance market competitiveness and secure price premiums, aligning with DOI's compatibility principle (Rogers, 2003). For oranges, this need is especially urgent due to perishability and specialized post-harvest requirements, unlike maize (Magesa et al., 2014). The findings indicate the necessity for:

i) Visual-based extension tools to overcome literacy barriers
ii) Mobile-enabled quality alerts timed with harvest windows
iii) Local demonstration hubs for hands-on post-harvest skills

"The dissemination of this information is very essential in helping farmers produce quality oranges that can attract good prices." (Village leader)

Market outlets (67%) and current market prices (64%)

The reliance on informal channels reflects the incompatibility of many digital tools, which often require advanced literacy or use English-language interfaces. DOI's principle of cultural and linguistic compatibility is therefore critical (Rogers, 2003). Compared with maize,

Table 4. Challenges facing smallholder orange farmers (n=103).

Challenges	SA (%)	A (%)	N (%)	D (%)	SD (%)
Lack of library/information center	88	6	1	3	2
Low ICT literacy	88	2	0	2	7
Low support from extension officers	86	2	1	4	6
Distance from information sources	85	5	0	3	7
Inadequate ICT infrastructure	83	5	0	4	8
Absence of price boards	82	8	1	4	6
Inadequate content information	81	8	1	3	8
Inability to access market information	78	16	1	4	2
Low income (cannot afford devices)	76	16	1	2	5
Inadequate market information knowledge	65	15	2	5	14
Format and language barriers	29	27	2	3	39
Lack of farmers' associations	21	16	15	4	44

SA = Strongly Agree, A = Agree, N = Neutral, D = Disagree, SD = Strongly Disagree.

the orange sector faces higher market volatility, which demands context-sensitive solutions such as Kiswahili voice-based platforms, icon-driven interfaces, and blended analog-digital systems (SMS plus community radio) to improve access**.** *"The app is in English; I only know Kiswahili. How can I use it?"* (Female farmer).

Other market intelligence needs

Needs for supply/demand trends (55%), sale timing (40%), transport costs (36%), and tax duties (27%) show farmers' preference for actionable and immediately beneficial information, consistent with DOI's principle of visible returns (Rogers, 2003). Farmers prioritise profit-oriented metrics over institutional knowledge like tax duties (Mnimbo et al., 2017). To operationalize these insights, context-adapted tools are recommended: predictive SMS alerts for surplus timing, USSD platforms with geotagged transport costs, and radio-based visualizations of market risks to enhance observability across literacy levels. Thus, findings highlight a distinct contrast with maize farmers: while maize farmers often rely on institutional and production-related information, orange farmers prioritise skills and quality to navigate volatile, intermediary-driven markets. This underscores the need for commodity-specific extension approaches that balance immediate market empowerment with gradual introduction to broader institutional knowledge.

Challenges in accessing and using market information

The researcher also wanted to explore the challenges faced by smallholder orange farmers. Findings from the analysis are summarized in Table 4.

Low ICT literacy (88%) and format/language barriers (29%)

The widespread lack of ICT skills and language incompatibility significantly hinder adoption of digital tools, reflecting DOI's complexity and compatibility principles (Rogers, 2003). These constraints disproportionately affect women farmers (61%) due to gendered educational gaps, aligning with feminist critiques of technology design (Wajcman, 2010). Compared with staple crops like maize (Isaga and Kileo, 2022), oranges require more immediate and precise market information, making inclusive digital solutions critical. This necessitates icon-based interfaces, voice-controlled Kiswahili platforms, and community digital literacy hubs to ensure equitable access. *"Sometimes the information comes in English, but we speak Kiswahili here. It is hard to understand"* (Extension officer).

Lack of information centers (88%) and price boards (82%)

The near absence of formal information points forces reliance on informal networks, limiting trialability and observability of benefits as outlined by Rogers (2003). For perishable commodities like oranges (Magesa et al., 2014), low-cost village kiosks and mobile-enabled community bulletin boards could transform hearsay into actionable intelligence. *"We don't have any office or centre to ask for market updates. We depend on what others say, and sometimes it i's not true."* (Village leader)

Distance (85%) and inadequate ict infrastructure (83%)

Geographic isolation and poor connectivity diminish the

relative advantage of digital solutions (Rogers, 2003), a challenge particularly severe in remote orange-growing zones (Mnimbo et al., 2017). Addressing these barriers requires expanded mobile networks, solar-powered community charging stations, and offline-capable USSD services to ensure timely access. *"We are far from town, and the phone signal is weak. We hear about prices too late."* (Village leader)

Low income (76%) and gendered dimensions

Economic constraints intersecting with gender inequalities limit smartphone ownership (15% female ownership) and mobility (85% female constraints), hindering technology adoption (Wajcman, 2010). Subsidized shared-device programs, women-led trader collectives, and audio-based market alerts for basic phones are critical to bridging this gap. *"I just have a small phone for calls. I can't afford the other type"* (Village leader).

Limited extension support (86%) and weak farmers' associations (21%)

Insufficient contact with extension officers and low levels of collective organization reduce trialability of innovations and bargaining power in the market (Rogers, 2003; Magesa et al., 2014). For orange farmers who require coordinated market entry, embedding market-focused modules in extension training and establishing commodity-specific associations is essential. *"The officers come maybe once a season and they only talk about farming methods, not how or where to sell"* (Extension officer). The identified challenges reveal that smallholder orange farmers face both structural and socio-economic barriers, with compounded effects for women**.** Compared to staple crops like maize, oranges require more immediate, skill-oriented, and context-sensitive interventions due to perishability and market volatility, highlighting the need for targeted, inclusive, and technologically appropriate strategies.

Conclusions

This study reveals that Tanzanian smallholder orange farmers face significant market information barriers, predominantly shaped by low digital literacy, linguistic incompatibilities, and infrastructural constraints. The predominance of women in this sector facing intersectional marginalization through limited resource access and mobility further compounds these challenges. Crucially, farmers prioritize actionable knowledge like price negotiation and quality standards, reflecting their alignment with income-generation objectives yet hindered by innovation complexity.

These findings extend Diffusion of Innovations theory by demonstrating how *compatibility* (cultural/linguistic alignment), *relative advantage* (tangible profitability), and *complexity* (technical skill barriers) manifest uniquely in perishable crop value chains compared to staple crops. The persistent reliance on informal information channels underscores systemic gaps in accessible, gender-responsive service delivery.

RECOMMENDATIONS

i) Establish Local Information Centers: Set up village centers with Kiswahili-speaking staff and offline digital tools (tablets) to provide accessible market information and price boards.
ii) Strengthen Extension Services: Increase visits by officers to train farmers on negotiation, quality standards, and basic ICT use, using gender-sensitive approaches.
iii) Promote Farmer Associations: Support the formation of groups to enhance collective bargaining, information sharing, and peer learning.
iv) Develop Accessible Information Systems: Deliver orange-specific market data via simple channels like SMS or radio in Kiswahili, avoiding complex apps/English.
V
v) Provide Financial and Digital Literacy Support: Offer subsidies/loans for basic phones and tailored digital literacy training, especially for women and low-income farmers.
vi) Improve ICT Infrastructure: Government investment in rural internet/mobile coverage is critical to overcome connectivity barriers.

STUDY LIMITATIONS

The findings' generalizability may be constrained by focusing on two villages with unique socio-agrarian contexts. While response bias from self-reported questionnaires was mitigated through triangulation, time and resource limitations restricted the sample to 133 farmers—statistically adequate but potentially insufficient to capture Muheza District's full experiential diversity.

ACKNOWLEDGMENTS

The authors express their sincere gratitude to all the study participants for their cooperation and valuable contributions to this research.

FUNDING

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.
The authors declare no conflicts of interest.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

American Psychological Association (APA) (2017). Ethical principles of psychologists and code of conduct. https://www.apa.org/ethics/code

Awoke TT, Amsalu A, Leta G (2025). The impact of smallholder farmers' knowledge on climate change adaptation on food security in Tanzania. Journal of Agricultural Extension and Rural Development 17(1):23-34.

Bontsa NV, Mushunje A, Ngarava S (2023). Contribution of smallholder farmers to food security and opportunities for resilient farming systems. Frontiers in Sustainable Food Systems pp. 7:1149854. https://doi.org/10.3389/fsufs.2023.1149854

Braun V, Clarke V (2006). Using thematic analysis in psychology. Qualitative Research in Psychology 3(2):77-101. https://doi.org/10.1191/1478088706qp063oa

Changalima IA, Ismail IJ (2022). Agriculture supply chain challenges and smallholder maize farmers' market participation decisions in Tanzania. Tanzania Journal of Agricultural Sciences 21(1):104-120. https://repository.udom.ac.tz/handle/20.500.12661/4476

Cochran WG (1977). Sampling techniques (3rd ed.). Wiley.

Creswell JW, Plano CVL (2018). Designing and conducting mixed methods research (3rd ed.). Sage Publications.

Dearing JW, Cox JG (2018). Diffusion of innovations theory, principles, and practice. Health Affairs 37(2):183-190. https://doi.org/10.1377/hlthaff.2017.1104

Dillman DA, Smyth JD, Christian LM (2014). Internet, phone, mail, and mixed-mode surveys: The tailored design method (4th ed.). Wiley.

Diwakar KC, Roberts RE, Quach S (2023). Factors affecting the smallholder farmers' participation in the emerging modern supply chain in developing countries. Asia Pacific Journal of Marketing and Logistics 35(2):266-289. https://doi.org/10.1108/APJML-07-2022-0592

Fowler FJ (2014). Survey research methods (5th ed.). Sage Publications.

Fresh P (2023). Tanzania targets $2 billion horticultural exports by 2030. https://www.freshplaza.com/africa/article/9761447/tanzania-targets-2-billion-horticultural-exports-by-2030/

Isaga N, Kileo E (2022). Market access and agricultural productivity: Evidence from smallholder farmers in Tanzania. African Journal of Economic and Management Studies 13(2):189-204. https://doi.org/10.1108/AJEMS-05-2021-0234

Kalimangasi NA, Nyagango AI, Mushi RM (2021). Factors constraining the use of mobile phone technologies for accessing agricultural marketing information by grape smallholder farmers in Tanzania. SAGE Open 11(4). https://doi.org/10.1177/21582440211014460

Lincoln YS, Guba EG (1985). Naturalistic inquiry. Sage Publications.

Magesa MM, Michael K, Ko J (2014). Access to agricultural market information by rural farmers in Tanzania. International Journal of Information and Communication Technology Research 4(7):264-273.

Mapiye O, Makombe G, Molotsi A, Dzama K, Mapiye C (2023). Information and communication technologies (ICTs): The potential for enhancing the dissemination of agricultural information and services to smallholder farmers in sub-Saharan Africa. Information Development, 39(3), 638–658. https://doi.org/10.1177/02666669221077322

Mazibuko DM, Gono H, Maskey S, Okazawa H, Fiwa L, Kikuno H, Tsubo M (2023). The sustainable niche for vegetable production within the contentious sustainable agriculture discourse: Barriers, opportunities, and future approaches. Sustainability 15(6):4747. https://doi.org/10.3390/su15064747

McCampbel M., Adewopo J, Klerkx L, Schut M (2023). Are farmers ready to use phone-based digital tools for agronomic advice? Ex-ante user readiness assessment using the case of Rwandan banana farmers. Agricultural Systems pp. 205:103578. https://doi.org/10.1016/j.agsy.2022.103578

Mnimbo TS, Lyimo-Macha J, Urassa JK, Mahoo HF, Tumbo SD, Rwehumbiza F (2017). Influence of gender on roles, choices of crop types and value chain upgrading strategies in semi-arid and sub-humid Tanzania. Food Chain 7(2):117-131. https://doi.org/10.3362/2046-1887.2017.008

National Bureau of Statistics. (2022). Tanzania national census 2022. Government of Tanzania.

Nunnally JC (1978). Psychometric theory (2nd ed.). McGraw-Hill.

Omotoso AB, Omotayo AO (2024). Postharvest food loss reduction and agriculture policy framework in Tanzania: Status and way forward. Agriculture and Food Security 13(1):34. https://doi.org/10.1186/s40066-024-00489-9

Patton MQ (2015). Qualitative research & evaluation methods (4th ed.). Sage Publications.

Rogers EM (2003). Diffusion of innovations (5th ed.). Free Press.

Sekaran U, Bougie R (2016). Research methods for business: A skill-building approach (7th ed.). Wiley.

Silvestri S, Richard M, Edward C, Dharmawan AH, Rufino MC (2021). Radio and SMS-based interventions to upscale climate-smart agriculture among smallholder farmers in Tanzania. Climate and Development 13(7):592–604. https://doi.org/10.1080/17565529.2020.1825927

Siwandeti M, Israel B, Mahuwi L (2023). The effect of supply chain factors on market participation among smallholder cereal crop producers in Tanzania. SAGE Open 13(2). https://doi.org/10.1177/21582440231164544

Tanzania Meteorological Authority (TMA) (2023). Annual rainfall report for Tanga Region. Government of Tanzania.

The Citizen (2024). What 44 percent rise in horticulture exports means to Tanzania. https://www.thecitizen.co.tz/tanzania/magazines/what-44-percent-rise-in-horticulture-exports-means-to-tanzania-4510004

United Republic of Tanzania (URT) (2019). Agricultural sector development programme phase II (ASDP II). Ministry of Agriculture.

Wajcman, J. (2010). Feminist theories of technology. Cambridge Journal of Economics 34(1):143-152. https://doi.org/10.1093/cje/ben057

World Bank (2023). Tanzania exports of oranges, fresh or dried (HS 080510). World Integrated Trade Solution (WITS). https://wits.worldbank.org/trade/comtrade/en/country/TZA/year/2023/tradeflow/Exports/partner/ALL/product/080510

Yamane T (1967). Statistics: An introductory analysis (2nd ed.). Harper and Row.

Zondo LT, Ndoro JT (2023). Drivers of mobile commerce adoption among young farmers in South Africa: A diffusion of innovations perspective. African Journal of Science, Technology, Innovation and Development 15(7):889-900. https://doi.org/10.1080/20421338.2023.2186656